Report for 2001AK3461B: Fingerprinting organic material in the Caribou-Poker Creek Watershed to support hydrologic investigations

- Articles in Refereed Scientific Journals:
  - White, D. K. Yoshikawa, and D. Garland, (2002), Fingerprinting dissolved organic matter to support hydrologic investigations, Cold Regions Science and Technology, Vol. 35, pp. 27-33.
- Dissertations:
  - Jaspreet Narr (2001), Disinfection By-Product Experiences in Alaskan Village Drinking Water Systems and the Caribou-Poker Creek Watershed. MS. Environmental Engineering, Thesis, University of Alaska Fairbanks.
  - Vincent Autier (2002), Predicting Contaminant Transport Pathways in the Caribou-Poker Creeks Watersheds. MS. Civil Engineering, Thesis, University of Alaska Fairbanks.

Report Follows:

Problem and Research Objectives:

The Caribou and Poker Creek Watershed (CPCRW) is an important component of the Bonanza Creek LTER (Long Term Ecological Research) Program. The CPCRW serves as a testbed for process studies on interactions between hydrology, meteorology and permafrost. By characterizing the nature and origin of organic matter in water below or above permafrost, in interpermafrost springs, and in streams this project sought to better describe the influence of permafrost on the hydrology in this region. In addition to a better understanding of the hydrology of permafrost watersheds in general, understanding the origin of organic matter is important for studies on drinking water treatment and use. Many public drinking water systems in Alaska extract water from above or below permafrost. Depending on the origin of the organic matter, certain health risks may be present.

NOM in water from the CPCRW was collected and subjected to a suite of analytical tests including dissolved organic carbon (DOC), apparent molecular size fractionation, ultraviolet absorbance. NOM was also fingerprinted using pyrolysis-G/MS. Fingerprint analysis was used to help determine the character and origin of surface water contributing to groundwater and vice versa during different seasons.

Methodology

Site Selection

The CPCRW served as an ideal research watershed for investigation. Water samples were collected from wells, streams, and springs from three different sub-watersheds (C2, C3, and C4). Mr. Vincent Autier, the graduate student working on the project, collected and analyzed all water samples under the direction of Dr. Kenji Yoshikawa.

Pyrolysis-gas chromatography/mass spectrometry (py-GC/MS) of water samples

Py-GC/MS was conducted with a CDS Model 2500 pyrolyzer and state of the art autosampler in tandem with a gas chromatograph/mass spectrometer (GC/MS). During pyrolysis the sample was heated from a starting temperature of 25 ^{o}C to 700 ^{o}C in 0.1 seconds and held at a constant 700 ^{o}C for 9.9 seconds. The pyrolysis reactor was mounted on an HP 5890 Series II GC, with a Supelco SPB 35 (35% Ph Me silicon) column, 60 m x 0.25 m x 0.25 µm. The GC interface temperature was set at 235 ^{o}C. The GC temperature program was 45 ^{o}C for 5 minutes, 2 ^{o}C /min to 240 ^{o}C and held for 25 min. The GC was plumbed directly to an HP 5971A Series Mass Selective Detector on electron impact (EI) mode. The MS scanned mass units 45 to 650. All mass spectra were compared to the NBS54K spectral library. Helium served as a carrier gas at a flow rate of 0.5 cm^{3}/minute. Each sample was injected with a split ratio of 1:50.

The fingerprinting technique provided us with generalizations and specifics about the chemical make-up of NOM and how it changed during the course of the year. As in White and Beyer (1999), we expected to correlate the organic matter in various samples with the probable origin.

Principal findings and significance

A detailed analysis of organic matter in 33 spring, stream and groundwater samples was made. Analyses of organic matter in the water samples showed that certain waters had very similar fingerprints, indicating either a similar source, or organic matter that had undergone similar transformation processes (White et al. 2002). Further analysis of seasonal variations, however, suggested that these relationships changed during the course of the year. The results suggested that springs and streams in the watershed were fed from different sources during different seasons. One significant finding was that winter samples from springs and streams were depleted in chemical signatures known to cause adverse health effects when treated for drinking water. These signatures, derived from aromatic molecules, were abundant in the summer, suggesting that their source is soil organic matter that is transported by surface runoff or short residence time interflow. The results suggested that these organic structures are removed from the water by chemical or biological activity when subjected to substantial subsurface residence times.